

Normal Heart Sizes Of Nigerians Within The Southeast Using The Cardiothoracic Ratio

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ABSTRACT

This research considered the heart sizes of one thousand and eighteen adult Nigerians of both sexes within the southeast as a result of racial variations, which has been noted to affect the sizes of the heart. Their posterior-anterior chest radiographs were obtained and the heart sizes were established using the method of cardiothoracic ratio (CTR) established by Danzer in 1919. A mean CTR value of 46.7 ± 4.3 was established for the sampled population and mean values of CTR set for the various age categories of the male and female populations. Lower and upper limits of normalcy of the CTR values for the studied sample was recorded to be between 40 and 50%.

Key words: Cardiothoracic ratio, Heart diameter, Chest radiograph.

Heart measurement is done by a variety of imaging methods. Chest x-ray has come to be one of the common ways of ascertaining heart size, despite the advent of new technologies that make it possible to accurately evaluate both cardiac size and volume with variety of invasive and non-invasive methods (Tatsuji et al 1991). Posteroanterior chest radiograph has become the most common, because of the obviously easy availability and affordability (Obikili and Okoye 2004). It also has the advantage of technical simplicity and wide spread availability of equipment particularly in the developing countries. Cardiothoracic ratio (CTR) is the ratio of the chest diameter with the heart diameter expressed in percentage as is seen on the chest radiograph. Since the establishment of this ratio by Danzer since 1919 as an index of heart size, (Danzer, 1919), it has become the formula for heart size assessment with the simplest technique. So many researches have been done and several values established for CTR, amongst Caucasians (Mihara et al 1989, Juhl and Paul 1987). In normal people, the CTR is usually less than 50% and any value greater than 50% is abnormal in adults.

With the introduction of racial variation in the value of CTR by Kerwin (1944) and by Nickol and Wade, (1982), it becomes imperative to establish normal values of CTR within the

Nigerian ethnicity that will enhance better clinical interpretations.

MATERIALS AND METHODS

This is a prospective study of the cardiothoracic ratio within Nigerians in the Southeast. The study centers are the University of Nigeria Teaching Hospital (UNTH) Enugu, Nigeria and Hansa, Special Diagnostic Centre, Enugu, Nigeria.

All the posteroanterior (PA) chest radiographs used for the study were made under identical conditions. The films were non-grid at 72 inches taken at 100 to 110 kvp. The tube was 1.8m from the subjects and the radiographs taken in the erect position at normal quiet inspiration. A total of one thousand eight hundred and eighty five (1885) samples after physical examinations were chosen for this study. The sample population was selected from candidates that came for chest x-ray examination as a result of requirements based on pre-employments, pre-admissions, visa applications and volunteer patients without any cardiovascular diseases symptoms, but based on technical details of the radiographs such as thoracic wall deformity, inadequate inspiration, over expanded chest, inability to determine one or both heart borders with confidence, incompletely erect radiograph,

mediastinal deviation and significant rotation. Forty six percent (46%) of the radiographs were rejected. A total of one thousand and eighteen (1018) radiographs that fell into the accepted group were used for this study. Ages of the candidates, sex, and blood pressure were also documented. Only candidates with normal blood pressure were considered for this research. Normal blood pressures considered in this study were cases with systolic blood pressure between 110 and 145mmhg and diastolic blood pressure between 60 and 110mmhg.

The transverse cardiac diameter was measured in the usual way described by Danzer (1919). Measurements were done to the nearest 0.1cm. No corrections were done for magnification. The transverse cardiac diameter of the heart is the sum of the greatest cardiac distance to the right and to the left of the midline, measurement of the transverse thoracic diameter

was taken at the level of the dome of the right diaphragm and measured as the widest horizontal distance inside the rib cage at this level.

RESULTS

Out of the one thousand and eighteen samples used for this study, males made up a total number of five hundred and ten (510) while females made up the rest five hundred and eight (508) of the sampled population.

Age was measured in years. The sample consisted of individuals from age four (4) to eighty (80). The mean age in the distribution gave 32.8 ± 15.14 . The age groups were broken into 10 years intervals.

The sampled population gave a mean chest diameter of 27.15 ± 2.7 , for males a mean chest diameter of 28.26 ± 2.7 was noted, while the value of 26.04 ± 2.3 was noted for females. Males showed a larger value of chest diameter

Table I: Relationships of Age and Chest Diameter (CM) by Sex

Sex	Age	Mean	N	S. D.	Range
Male	4-10	21.0	20	3.57	0.83
	11-20	26.6	81	4.48	0.30
	21-30	29.1	146	4.84	0.15
	31-40	29.4	100	4.97	0.21
	41-50	28.9	70	5.06	0.20
	51-60	28.5	62	5.10	0.22
	61-70	27.8	20	5.52	0.46
	71-80	28.1	11	5.07	0.48
	Total	28.3	510	4.91	0.12
Female	4-10	20.49	25	3.33	0.50
	11-20	25.59	79	4.26	0.22
	21-30	26.26	186	4.48	0.12
	31-40	26.85	100	4.57	0.17
	41-50	26.54	69	4.82	0.27
	51-60	26.40	33	4.91	0.34
	61-70	26.26	14	4.75	0.43
	71-80	24.95	2	5.10	0.75
	Total	26.04	508	4.52	0.10
Total	4-10	20.70	45	3.50	0.46
	11-20	26.11	160	4.38	0.19
	21-30	27.52	332	4.56	0.12
	31-40	28.12	200	4.84	0.16
	41-50	27.71	139	4.98	0.20
	51-60	27.74	95	5.04	0.21
	61-70	27.13	34	5.41	0.56
	71-80	27.62	13	5.05	0.56
	Total	27.15	1018	4.62	0.066

and also larger variations. Chest diameter correlated significantly and negatively with age ($r = 0.3, P = 0.01$) but positively with both heart diameter and CTR ($r = 0.7$ & 0.3 respectively, $P = 0.01$).

The sampled population gave a mean heart diameter of 12.64 ± 1.5 . The value for the male

Mean 12.6 1018 1.5

The result of the distribution gave a mean CTR of 46.20 ± 4.1 for males and 47.16 ± 4.1 for females and 46.65 ± 4.3 for both. Females recorded larger values of CTR than males with about the same deviation from the means. Age correlated positively and significantly with CTR ($r = 0.2, P \leq 0.01$).

Table 2: Relationship of Age with Heart Diameter

Sex	Age	Mean	N	S. D.
Male	4-10	9.8	20	1.8
	11-20	12.1	81	1.8
	21-30	13.2	146	1.2
	31-40	13.4	100	1.5
	41-50	13.6	70	1.2
	51-60	13.5	62	1.0
	61-70	13.6	20	1.5
	71-80	13.2	11	1.2
	Mean	13.0	510	1.5
	Female	4-10	10.1	25
11-20		11.6	79	1.1
21-30		12.0	186	1.1
31-40		12.8	100	1.1
41-50		13.1	69	1.3
51-60		12.7	33	1.0
61-70		12.9	14	1.4
71-80		12.1	2	1.4
Mean		12.3	508	1.3
Both		4-10	10.0	45
	11-20	11.9	160	1.2
	21-30	12.6	332	1.3
	31-40	13.1	200	1.4
	41-50	13.3	139	1.2
	51-60	13.2	95	1.0
	61-70	13.3	34	1.5
	71-80	13.0	12	1.1
	Mean	12.6	1018	1.5

The result of the distribution gave a mean CTR of 46.20 ± 4.1 for males and 47.16 ± 4.1 for females and 46.65 ± 4.3 for both. Females

recorded larger values of CTR than males with about the same deviation from the means. Age correlated positively and significantly with CTR ($r = 0.2, P \leq 0.01$).

Table 3: Relationship of Age with CTR

Sex	Age	Mean	N	S. D.
Male	4-10	46.8	20	2.6
	11-20	45.5	81	3.7
	21-30	45.4	146	3.6
	31-40	45.6	100	5.0
	41-50	47.4	70	4.2
	51-60	47.3	62	3.6
	61-70	49.0	20	4.4
	71-80	46.9	11	4.2
	Mean	46.2	510	4.1
	Female	4-10	49.7	25
11-20		45.5	79	3.4
21-30		45.9	186	3.8
31-40		47.9	100	3.9
41-50		49.6	69	6.1
51-60		48.2	33	2.9
61-70		49.0	14	3.8
71-80		48.7	2	4.2
Mean		47.2	508	4.4
Both		4-10	48.4	45
	11-20	45.5	160	3.5
	21-30	45.7	332	3.7
	31-40	46.7	200	4.6
	41-50	48.5	139	5.3
	51-60	47.6	95	3.4
	61-70	49.0	34	4.1
	71-80	47.1	13	4.0
	Mean	46.7	1018	4.3

DISCUSSION

It has been noted that sex, age, body size, race and ethnicity influence to varying degrees, the heart diameter and CTR. (Nickol & Wade 1982, Walker et al 1972, Ascroft & Miall 1969, Patrick & Boyd 1986). It was this platform that informed the bases of this study in Nigeria. Sexual variations have been established for all the measured and calculated parameters in this study, females showed smaller heart and chest diameters, but larger CTR values than the males, a factor attributable to morphological and physiological differences of both gender. This sexual difference observed in heart size and CTR has also been noted by other authors (Amundsen 1959, Zdansky 1969, Sorkin et al 1999, Inoue et al 1999).

Brainton (1932) in an orthographic study of transverse heart diameter, reduced the transverse heart diameter of men by 0.8cm to

Table 4: The cumulative frequencies of the grouped CTR values

Grouped CTR Value	Cumulative freq. For all the age groups			Cumulative freq. From age 20 & above		
	Male	Female	Both	Male	Female	Both
37-40	9.2	6.7	8.0	9.6	38.2	8.9
41-44	42.7	31.9	37.6	44.2	33.7	39.1
45-48	76.3	68.9	72.8	74.0	69.4	71.8
49-52	97.7	95.0	96.4	98.0	93.9	96.0
53-55	100	100.0	100.0	100.0	100.0	100

Table 5: The cumulative frequencies of the grouped heart diameters.

Grouped Heart Diameter	Cumulative freq. For all the age groups			Cumulative freq. From age 20 & above		
	Male	Female	Both	Male	Female	Above
8.5-9.5	2.3	4.2	3.2	0.0	1.0	0.5
9.6-10.5	6.1	13.4	9.6	1.0	8.2	4.5
10.6-12.5	19.8	32.8	26.0	13.5	27.6	20.3
11.6-12.5	45.0	32.8	55.0	38.5	62.2	50.0
12.6-14.5	69.5	67.2	79.6	62.5	89.8	75.7
13.6-14.5	89.3	90.5	93.2	87.5	96.9	92.1
14.6-15.5	100.0	100.0	100.0	100.0	100.0	100.0

Table 6: The values of the 80% central tendency in the CTR and heart diameter values of the sampled population.

Sex	Values for all the sampled age		Values for ages 20 & above	
	CTR (%)	Heart D (cm)	CTR (%)	Heart D (cm)
Male	40-50	10.9-14.6	40-49	11.4-14.7
Female	41-51	10.6-14.2	41-51	10.8-13.7
Both	40-50	10.6-14.5	40-50	11.0-14.4

Table 7: A sex differential observation in the chest and heart diameters and CTR values.

Age group	Difference in heart diameter	in	Difference in chest diameter	in	Ratio of difference in %
11-20	0.5		1		50
21-30	1.2		2.8		43
31-40	0.6		2.5		24
41-50	0.5		2.4		21
51-60	0.8		2.1		38
61-70	0.7		1.4		50
71-80	1.1		3.1		35
Mean	0.77		2.2		37.3

obtain the standard for women. The findings of this study reveal a consistent sex difference in heart diameter of 0.5 to 1.2cm with an average of 0.8cm against 0.5cm to 1.0cm observed by Oberman et al (1965) and also exactly with the average of 0.8cm observed by Brainton. This study apportions a difference of up to 37% in heart size variation to sexual difference as against 20% given by Oberman et al (1965).

A summary of previous works on CTR has shown the CTR values of Africans to be slightly higher than those of Caucasians (Nickol & Wade, 1982, Kabala & Wide 1987). All the subjects in this series were healthy and thus the entire ranges of CTR, heart and chest diameters may be regarded as normal. To obtain a more substantive value that will have upper and lower limits beyond which the occurrence of normal recordings are relatively infrequent, the 10th and 90th percentiles were used.

This research offers a central 80 percent ranges of the distribution of the studied population within which the ranges are certainly normal. This value when considered for all the age groups and also members of the population above 21 years (i.e. population of core adults) gave a range of 40-50%.

In comparison of the result of this work with other documented works, a strong proximity is seen with Nickol and Wade's result of 45.9% CTR for males with the mean of 46.2% gotten from this work for males. The overall mean CTR of 46.68% and range of 40-50% gotten from this work are also similar to the earliest figure of mean CTR value of 46% and range of 39-50% submitted by Danzer in 1919. A close similarity is also seen between the values of this result with those of Obikili et al (2004).

Close comparison of the CTR values of this work for the various age groups with Caucasian values of same age groups shows the research values slightly larger than the Caucasian values. This goes to confirm earlier reports by Obikili et al 2004, Nickol & Wade (1982), that Africans have slightly larger CTR values than Caucasians Asians.

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